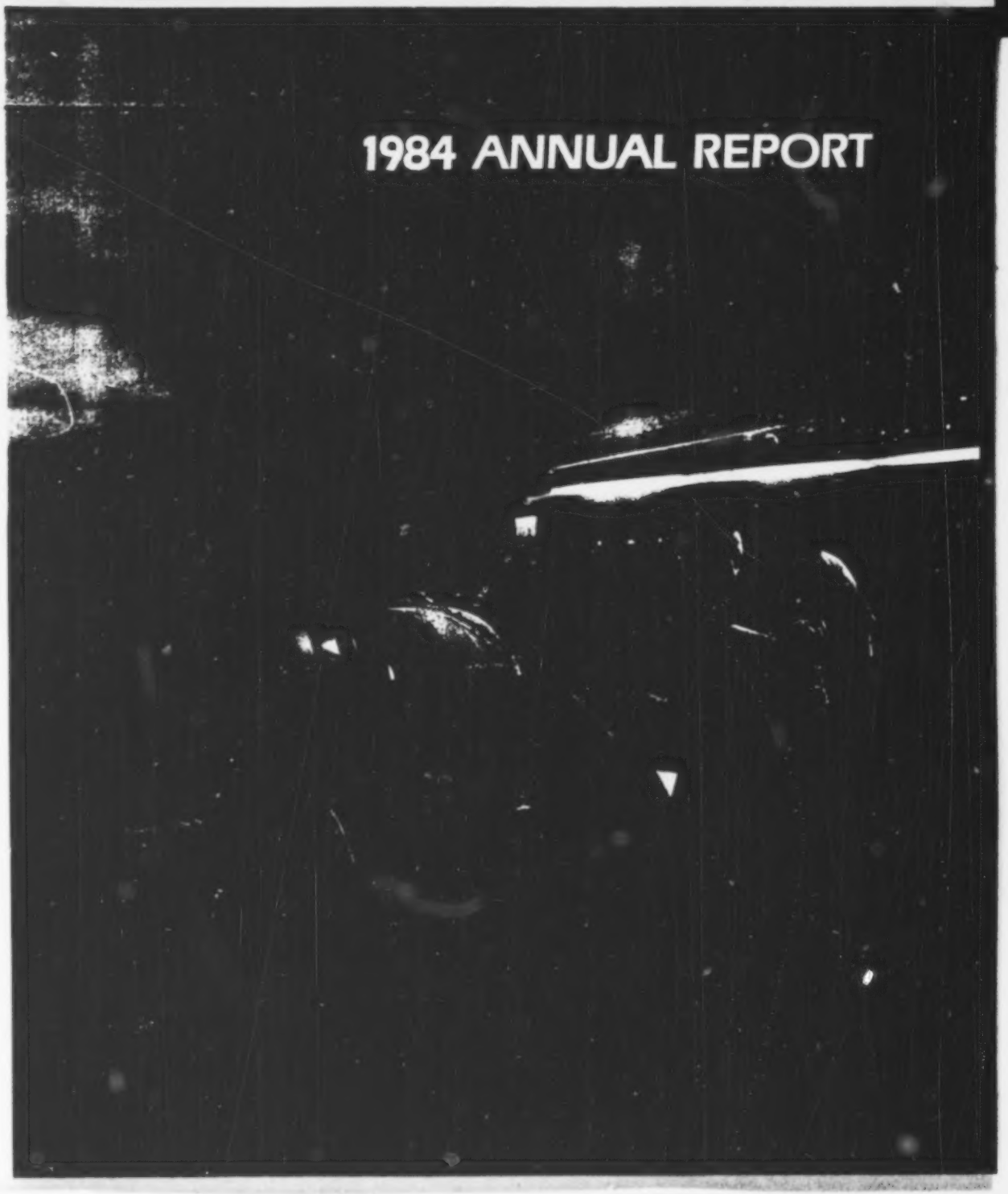
RESEARCH



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HIGHLIGHTS

Client base reaches new high with more than 2100 served in 1984.

New strategic plan developed.

ORF has lead agency role in two national energy programs.

CMS Rotordisk Inc. receives technical development assistance with prototype sewage treatment system.

Ceramic engine components are subjects of two new programs.

ORF technology commercialized for production of 2-ply tissue.

New Computer Aided Engineering group formed in July.

Dr. Gopola Gowda holds silica aerogel sample developed at ORF.

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Front Cover: ORF also serves a number of large manufacturers. Here Dr. Geza Matolcsy (left) discusses operations with Gordon McWilliams, of Dominion Cellulose.

A NOTE FROM THE CHAIRMAN

This annual report covers a period of major organizational change for Ontario Research Foundation. The Board of Governors is pleased that management has successfully restructured operations to meet the imperatives of a changing and shrinking world. ORF also established a comprehensive strategic plan in which vital new initiatives are identified and addressed. During 1984, ORF increased its gross revenue by nearly 12 percent and increased its client base beyond 2,100 – indicative of its supportive and encouraging participation in Ontario's industrial renaissance.

Now well positioned for further advances, ORF sees companies large and small facing challenges which will be overcome only through similar productive change – along with courage and innovative action.

In this, my last Chairman's Message, I want to exhort leaders in both public and private sectors to organize our human and financial capital for maximum competitiveness in the near future: the issue is world class performance – nothing else will ensure our survival.

This requires thoughtful and intensive strategic planning for technology development in virtually every field. This is strategy with which we are generally unfamiliar. But our traditional reliance on natural resource export and foreign-owned, branch-plant manufacturing will not work any longer.

We claim to be technologically advanced but, for the most part, we sell our resources and buy back high tech. While the U.S. sells about two and a half times as much in high tech products as it imports, we sell less than we buy.

But the most alarming trend shows up in the application of new technology by the so-called developing countries – countries which are learning to exploit their own natural resources **and** manufacture goods for sale at low prices on world markets. The more experienced these budding technocrats become, the more competitive they will be.

It is obvious we must become better at manufacturing. Technology can enable us to get more function out of less raw material – helping us conserve resources while improving our own product availability. Technology can modernize our manufacturing processes so that we can compete more successfully for our own home markets. It can allow us to use substitute materials, often more cheaply, to produce more efficient, cost-effective, products for overseas markets. Technology can help us manufacture more of the kinds of products still needed by the newly industrialized nations – advanced products such as composites and engineered plastics, medical devices, satellite-based telecommunications systems, laser cutting tools, electronically operated machinery, software and systems for countless computer applications.

Canadian scientists and engineers are among the most skilled in the world. They have given us some of the most dramatic developments in the history of invention. Our ability to explore, to innovate, to make the most of an opportunity, has been proved time and again. We can be proud of our accomplishments. But we have not changed our attitudes to keep pace with the world. We have not matured along with technology. We are therefore now vulnerable to competition from other countries which have pursued technology and exercised their options to the full.

Hence my urgent call for strategic planning of a high order. We must seize the remaining opportunities quickly and consolidate our current fragile grip on our own future. We can succeed. Even though we are a country of relatively small manufacturers, we have the means for developing world class technologies in virtually every field.

Ontario Research Foundation can help even the smallest operations in areas such as new design, modifications, quality upgrading, increased productivity and reduced operating costs. For a very reasonable investment, companies with little or no in-house engineering capability can enlist the services of highly qualified people and extensive scientific facilities. Essential R&D projects **can** be carried out. Larger operations can temporarily extend their research capabilities into specialized fields without a major investment in additional people and equipment.

Practical and financial help is available in various ways from a number of sources: Ontario Research Foundation can help manufacturers take advantage of all benefits, seeking out the most effective course for each individual situation.

In describing ORF's dynamic approach to its responsibilities, Mr. Midghall sends a clear message to industry: make technological improvement your first priority – make sure our country wins the most important economic battle of its life.

In closing, I wish to recognize the outstanding contributions of recently retired Board members Mr. Tom Beck, Mr. Alton Cartwright, Mr. Jim Kerr, Mr. Wilfred Posluns, Mr. David Radford, Dr. George Sinclair and Dr. Bill Winegard.

Donald Chisholm

Dr. D.A. Chisholm

Dr. D.A. Chisholm (centre right) and seven members of the ORF Board of Governors

Ontario Research Foundation is becoming increasingly concerned about accelerated, worldwide technological change which affects individuals, organizations and nations. In this information age, newly industrialized countries are obtaining technology and combining it with low labour rates to become fiercely competitive. There is a rapid movement toward globalization of markets, with tariff barriers coming down in all countries including our own. For most businesses it is a period of reassessment and revitalization to direct resources toward future opportunities for growth. For Canadian industry this means providing products and services at a price and quality that are acceptable in increasingly competitive world markets.

Ontario Research has a unique role to play in assisting Canadian manufacturers not only to survive in this global arena but to be winners. We recognized last year that, to fulfill this role, our own efforts must be honed in order to better position ORF as a primary technological resource for industry. We knew we had the key ingredients, in terms of a world class, multidisciplinary technical staff and state-of-the-art hardware, to team up with Canadian business to meet the challenge. But we also recognized that these assets had to be realigned and new directions established in order to maximize our potential to serve Canadian industry in this effort. Therefore, our number one priority for 1984 became the establishment of a strategic plan – an initiative which may be as great and as full of promise for ORF as was our founding as an independent joint venture of Canadian industry and the Ontario government in 1928.

REORGANIZATION

As a first step toward gearing up for strategic planning, we decided early in the year to reorganize. A major result of that decision has been the establishment of Technology Development and Business Development as the key line functions, each headed by a Vice President. The two Vice Presidents work closely together to ensure that there is prompt and continuous attention given to clients from initial contact with ORF to the time a final report on a project is delivered. All organizational changes have been made with the view that the needs of our clients are foremost, strengthening our ability to give full expression to our people's knowledge, skills and experience in all facets of this vital organization.

Joining these two Vice Presidents and myself to form a Management Committee are the Vice President, Human Resources Management, the Vice President, Finance and Treasurer, and the Vice President, Corporate Facilities and Secretary.

Over an active seven-month period, this Committee joined with our Business Centre managers to pull together ORF's first strategic plan.

Our mission was defined and a set of corporate values, emphasizing social responsibility and client service, were established. We also analyzed our business lines and positioned them in terms of market appeal and competitive strength. Finally, we set our objectives and developed action plans.

Our mission: We are a comprehensive technology consulting enterprise serving commercial and government organizations. We help businesses to innovate through product and process development, and to improve productivity, product quality and competitiveness.

Our plans for aggressive controlled growth over the next five years centre on a portfolio approach to managing our present technology/business centres along with the introduction of three new initiatives.

COMMERCIAL ADVANCED INDUSTRIAL MATERIALS

Our strength in materials research and development supports the establishment of ORF as a leading authority in Ontario and Canada in Commercial Advanced Industrial Materials (CAIM). High performance ceramics, metals and composites are specific technological areas for further development. Our staff met with key interest groups, and in concert with the Canadian Manufacturers' Association we hosted a conference on the commercial application of advanced materials. We also conducted a state-of-the-art review on this general subject area.

Ahead lies the challenge of networking the special interest groups and the development of a national program with ORF as a major participant.

ADVANCED TECHNOLOGY INFORMATION SYSTEMS

We believe that technology transfer is key to the development of Canadian manufacturing industry for it to compete in the world market place. Therefore we plan to put in place Advanced Technology Information Systems (ATIS) at ORF. This program will feature the collection of advanced technological information from around the world as well as its dissemination both internally and to a network of our large and small clients. We have positioned ORF so that it can apply its resources effectively to problems and opportunities of the information age, and have made a major financial commitment to the ATIS program.

CLIENT CENTRES

Our third initiative involves a program for the possible development of ORF Client Centres in other regions of Ontario. These would be staffed laboratories and offices, possibly even small groups that serve the dual purpose of housing technical facilities and staff to solve local area problems and providing a business development staff to serve companies in the region.

These Client Centres would be backed by the staff in our Sheridan Park location.

ADVANCED TECHNOLOGY AND CONTINUING GROWTH

We project total revenue to double by 1989, accompanied by significant staff growth. And we believe 1984 results provide ORF with a solid foundation for that growth.

Looking back at 1984, revenue increased twelve percent to $21 million, with most of this increase coming from professional services; investment and royalty income showed significant increases from the preceding year. We expect this trend to continue. The relatively large revenue increase allowed us to reinvest earnings in the business in a manner that will contribute to our growth. Improvements were made to the employee benefit program, and a number of other changes were made which are expected to contribute to improved employee satisfaction and development. To further facilitate our growth, we have committed to a sizeable increase in capital funding in 1985 – an investment in capital that is a necessary pre-requisite to maintaining our pre-eminent position.

The key ingredient in our plans for technological advancement and significant growth is the ORF organization itself. First, I am grateful for the support and enthusiasm of our prestigious Board of Governors, which has provided me with realistic and challenging direction.

Our new Management Committee is successfully leading the entire organization in a business oriented direction, ensuring that we operate as a business and carry out our activities in such a way as to be relevant to Canadian business.

STRENGTH IN HUMAN RESOURCES

In my first full year at ORF I have been singularly impressed by the staff. In few organizations is there the

range of experienced specialists of which we can boast – specialists who are accustomed to working effectively as multidisciplinary teams. We will build on this special strength through development of integrated technological management practices and by investment in new management information systems to improve our productivity.

To all of the staff of Ontario Research – scientific, engineering, technical and managerial – I express my appreciation for their ingenuity and resourcefulness in conducting the great diversity of projects to the satisfaction of our thousands of industrial clients and government agencies. This was accomplished during a year of transition in which their time was also needed for charting a new course for ORF.

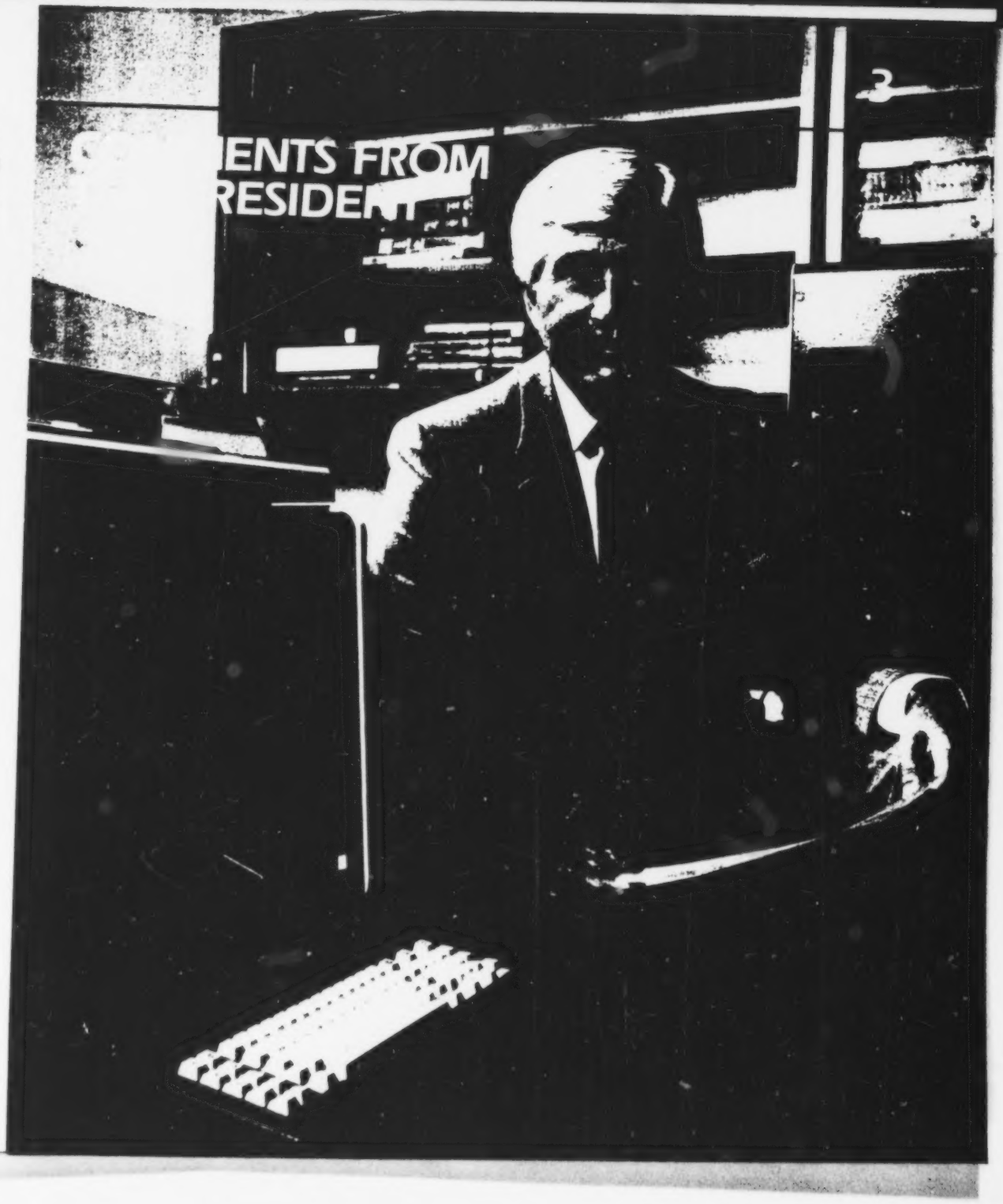
To ensure that our staff has a stimulating and satisfying work environment in the years ahead, we have implemented programs to improve individual scientific and management skills and provide opportunities for career growth.

We are thankful once more to the Ontario government for an important grant that has enabled us to invest in newer technological developments and thus continue to stay abreast of fast changing technology, all in the interest of better service to our clients. We now have an aggressive strategic plan in place – a plan, we believe, that will have a significant impact in meeting the explosive technology thrusts of today and tomorrow in Ontario and all of Canada.

We are poised to meet the challenges presented by both present and future clients. Indeed we urge all manufacturers, large and small, to gain that all-important competitive edge with the help of our comprehensive technology services.

W. Paul Midghall

W. Paul Midghall



ORF President W. Paul Midghall with state-of-the-art Fourier Transfer Infrared equipment which uses infrared spectroscopy to monitor the effects of laser irradiation on advanced materials. Mr. Midghall emphasizes that promoting emerging technologies such as lasers / advanced materials is of high strategic importance at ORF.

Ontario Research continued to work for industry and government on programs relating to energy conservation and deriving energy from waste. Projects included energy storage, more efficient energy use, and new or alternative fuels.

ENERGY CONSERVATION

A new major program was initiated on behalf of Energy, Mines and Resources Canada, with Ontario Research Foundation designated as a Lead Agency. This program concerns air quality assessment and ventilation patterns in R2000 (energy-efficient) houses. These houses are constructed to minimize energy losses through the building shell. The program deals with testing and evaluating air-to-air heat exchangers, heating systems, insulation materials, sealants, and air vapour barriers; testing and evaluating building assemblies to determine thermal effects, and effects of wind loading, moisture, aging and durability. The program also monitors air quality and provides assistance in monitoring overall energy performance of a sample of R2000 homes across Canada. A review of appropriate heating and ventilation equipment and systems is included for low energy homes. This program will continue in 1985.

In addition, our Building Performance Centre secured a contract to evaluate the effects of polyurethane foam in the R2000 building program.

Emissions of residential wood-burning furnaces were characterized and thermal efficiencies determined for different furnaces. The study was carried out in Dorset, Ontario for the Ontario Ministry of Energy and IEA Consulting Group.

For Canadian Solifuels Ltd. a design and development program of a 2.0-.05 million BTU/h burner fired with solid fuel pellets (Energex) was initiated in 1984. This is a new concept making use of indigenous biomass wood wastes, and when completed will be used in conventional oil and natural gas industrial boilers.

ORF's lead agency role in the Buildings Energy Technology Transfer Program (BETT) on behalf of Energy, Mines and Resources Canada encompassed numerous projects relating to the energy efficient operation and retrofit of existing high-rise apartment buildings. Work underway involves the development of "An Apartment Owner's Guide to Energy Conservation", and the application of high efficiency boilers for both domestic hot water and space heating applications. More than half of this work is conducted by private sector consultants under subcontract to ORF. This program will continue into 1985.

On behalf of the Canadian Electrical Association, a study was carried out to determine current trends and future needs in domestic hot water heating systems in Canada.

The audit portion of a new program, Canada Energy Audit Program (CEAP), was undertaken on behalf of Energy, Mines and Resources Canada. The energy audit offers free advice and assistance to industrial, commercial and institutional energy users on potential energy and dollar savings available. Two mini energy buses are equipped with on-board computer systems and all relevant monitoring instrumentation and support material to conduct the energy audits. The buses are operated by technical personnel specializing in energy auditing procedures and energy conservation technologies. During 1984, this free service was provided to over 200 industrial, commercial and institutional organizations throughout Ontario.

Laboratory testing of a prototype air source heat pump designed for northern climates was carried out on behalf of Keeprite Inc. The results identified operating performance characteristics under various simulated outdoor conditions using our Heat Pump Research and Development facilities. Performance testing of heating systems, including air-to-air heat exchangers and space heating systems was performed on behalf of various industrial clients.

For Agriculture Canada, a project was completed to study and evaluate new energy-conserving snow removal methods suitable for Canadian greenhouses. Also for Agriculture Canada, work continued on the field monitoring of a new generation greenhouse heating system, including the design and construction of the greenhouse, instrumentation used to monitor its performance, and comparison to the performance of an identical greenhouse structure using a conventional steam heating system.

Work was carried out over a two-year period on the development and evaluation of a high efficiency, low emission continuous grain dryer with hot air recirculation and exhaust heat recovery, for Agriculture Canada. An extension to this program monitored the facility for the 1984 drying season.

Three energy related test programs were carried out for VIA Rail Canada Inc. Steam condensate traps on passenger trains were evaluated for energy conservation potential, reliability and cost savings. Performance characteristics of prospective replacement shut-off end valves and pressure regulating valves were determined for existing passenger rail coaches. Performance evaluation of steam end valves and shut-off valves used on steam heated trains determined energy consumption, dependability and pressure drop characteristics.

A detailed investigation relating to the application of coal combustion technology in industrial boilers was undertaken for the Ontario Ministry of Energy. The results highlighted the potential opportunities and economic considerations of suitable combustion technologies.

A review of proposals to the Ontario Ministries of Energy and Environment dealing with energy from waste projects using facilities at Ontario's Experimental Plant for Resource Recovery, was conducted to provide an independent assessment of technical merit.

Additional studies have been completed for Michigan Technological University in the evaluation and optimization of a full-scale WETOX® plant at Uniroyal in Elmira, Ontario. Areas of energy losses were identified and recommendations for improvements made.

ALTERNATIVE FUELS

Ongoing programs continued in the area of developing technology for using propane and alcohol fuels in spark and compression ignition engines. A Massey Ferguson tractor equipped with a Perkins diesel engine, converted to operate on 100% methanol, was exhibited at the 6th International Symposium on Alcohol Fuels Technology in Ottawa. Another Perkins diesel engine has been modified to operate in a dual fuel ethanol/diesel mode to reduce dependence on diesel fuel. Up to 40% diesel substitution is possible using a fumigation technique.

In addition to work on methanol fuelled diesel type engines, a program on improving the cold start capability of 100% methanol fuelled passenger cars was carried out using Transport Canada's climate controlled vehicle test facilities, Blainville, Quebec. Fleet testing of low level methanol/gasoline blends was aimed at evaluating effects of reducing the cosolvent/methanol ratio in the fuel. A heavy duty propane engine based on a 350 H.P. Cummins diesel engine was developed, and is ready for road testing in a heavy duty tractor trailer rig. Durability and performance testing of propane spark ignition engines was carried out for Chrysler Canada Ltd.

Opportunities for the production of butanol from whey and the potential use of butanol and butanol/acetone/

ethanol mixtures in both gasoline and diesel engines have been assessed technically and economically as sub-contractor to R.F. Webb Limited, who are contracted to Agriculture Canada.

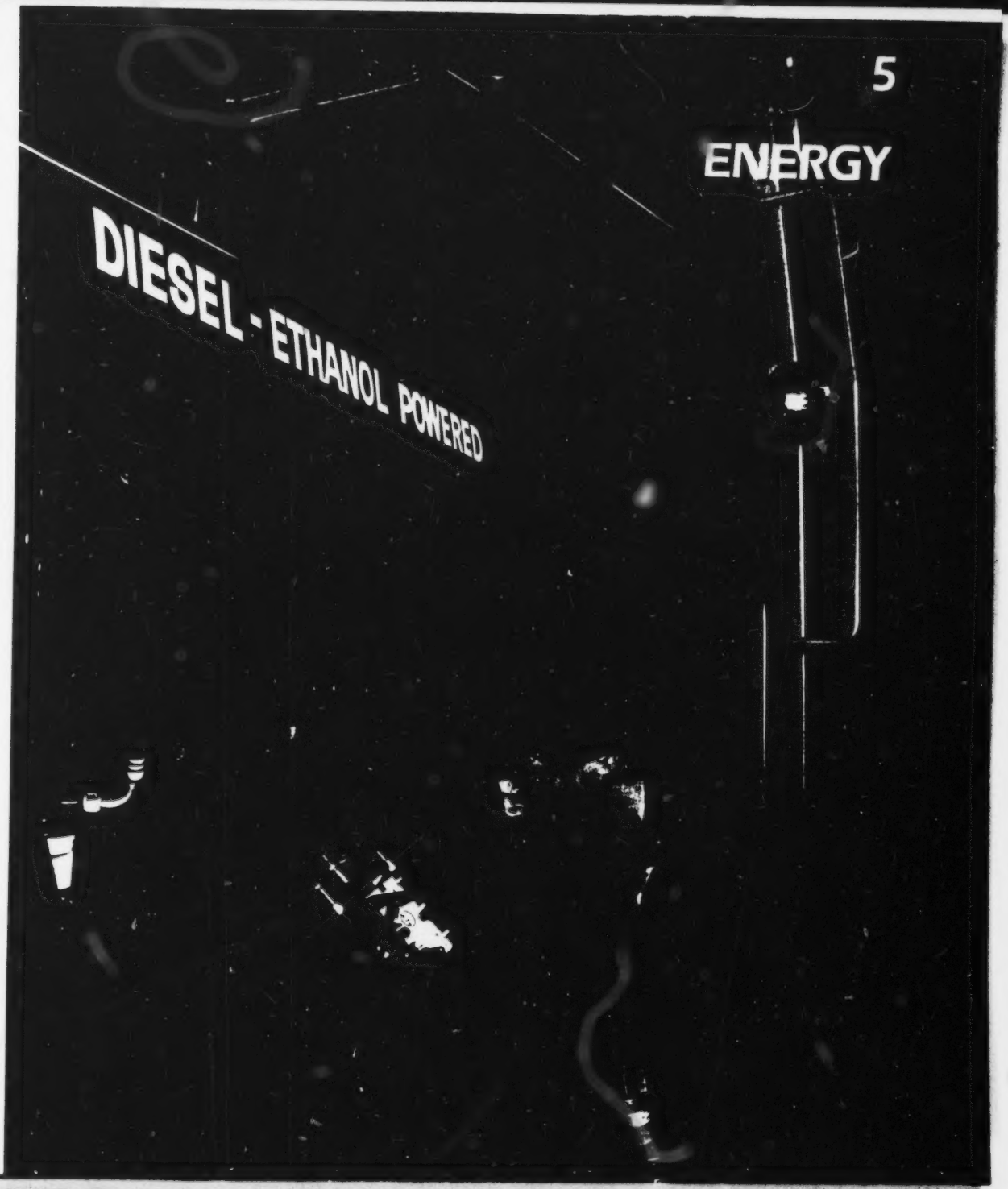
SOLAR ENERGY

The National Solar Test Facility (NSTF) is a federal government-owned operation with a mandate to perform predetermined routine tests for the Canadian solar industry on request. The facility is internationally recognized as the world's premier facility of its kind. Capabilities include testing of solar domestic hot water systems, photovoltaic panels and photovoltaic pumping systems, in conjunction with the microcomputer expertise of the Electronic Product Development group.

A program relating to construction of an improved Solar Domestic Hot Water Test Station began in 1984 and will be completed by March, 1985. This is a continuation of the project undertaken for the National Research Council for development of practical test methods and equipment for evaluation of SDHW systems.

Optimum integration of conventional space heating systems with passive solar systems in multi-storey buildings was studied on behalf of the National Research Council. The results and program highlights were presented at an NRC sponsored seminar.

Another project carried out under the National Research Council's Solar Energy Program examined the feasibility for the design of passive Solar Thermal Energy Storage (STES) construction materials, based on an ORF proprietary concept for resin microencapsulation of phase change chemicals. The STES materials can be designed with a range of operating temperatures which make them potentially suitable for incorporation in building products such as gypsum board.



Perkins engine in a Massey Ferguson tractor was converted to operate on an ethanol-diesel fuel combination.

The quality of our environment continues to be of concern to the Canadian public. Our involvement in environmental issues is extensive, and covers a wide range of activities, including the measurement, control and disposal of materials hazardous to the environment.

AIR

A new gas and particle sampler for the Atmospheric Environment Service (AES) was developed and a prototype was produced. The sampler uses molecular diffusion to separate the vapour fraction from the particulate fraction which is collected by filtration. This process will be applied to the sampling of trace hazardous organic pollutants in the atmosphere.

An alkaline particulate emission survey of anthropogenic sources was performed in conjunction with MEP Limited for Environment Canada as part of a study series related to the impact of acid rain. Emissions from open sources such as unpaved roads, agricultural tilling and construction activities far exceeded other sources and such emissions in general are higher in Western Canada, correlating with the higher precipitation alkalinity recorded in western provinces.

A comprehensive air quality survey continued in the Sarnia area for the Lambton Industrial Society. Daily sulphur dioxide (SO_2) criteria were not exceeded, reflecting the effectiveness of the SO_2 control strategy we developed with the L.I.S.

Mary Jane Hanley operates a new organic air sampler.

A project funded by Environment Canada was carried out for Environment New Brunswick at the Irving Oil Refinery in St. John to identify potential sources of off-property odours. A large equalization pond, and not stack emissions, was identified as the most probable source.

Coke ovens at three steel mills in Ontario were studied in order to establish appropriate emissions standards. The Ontario Ministry of the Environment commissioned the project, studying correlations between the organic soluble fraction of coke oven emissions, the identification of organic components and the results of short-term biological tests.

OCCUPATIONAL AND ENVIRONMENTAL HEALTH

Industrial hygiene and walk-through surveys were conducted at sixteen industrial plants employing welders. The study was conducted for the Ontario Ministry of Labour, sub-contracted to ORF by Hatch Associates Ltd. Exposure levels to several contaminants during various welding operations were determined. Types and effectiveness of work practices and controls used, and parameters affecting exposure were evaluated.

CANMET, the Ontario Ministry of Labour and the U.S. Bureau of Mines are jointly funding on-going projects involving the development of emission control technology for heavy-duty diesel engines in underground mines. Our Centre for Alternative Fuel Utilization has been evaluating the performance of particulate traps, filters, catalysts, methanol/diesel emulsions, and their effects on heavy-duty diesel emissions. Exhaust quality has been assessed on test engines in test cells and underground at Kidd Creek Mines, near Timmins, Ontario and Inco Mines near Sudbury, Ontario.

As a result of new regulations regarding diesel particulate emissions from heavy duty engines, emphasis is increasing on developing emission control technology for buses and trucks. Work was therefore carried out to develop technology for applying diesel particulate traps to 2-stroke bus engines.

WASTE TREATMENT

Comprehensive studies continued throughout the year for the Ontario Waste Management Corporation (OWMC). Twenty candidate areas for a liquid waste treatment facility were assessed with respect to existing air quality, surrounding topography, population density and other factors. After eight candidate sites had been selected, a detailed comparative analysis of all sites was initiated providing specific study reports on emissions, modelling and risk assessment. Planning for future baseline studies was completed and our staff participated in a public consultation program. A review of sixteen previous waste quantity studies was also made, identifying five major methodologies which were critically compared using representative studies from the review. OWMC also provided funding for the Ontario Waste Exchange, managed by ORF staff, to promote the exchange of wastes in Ontario.

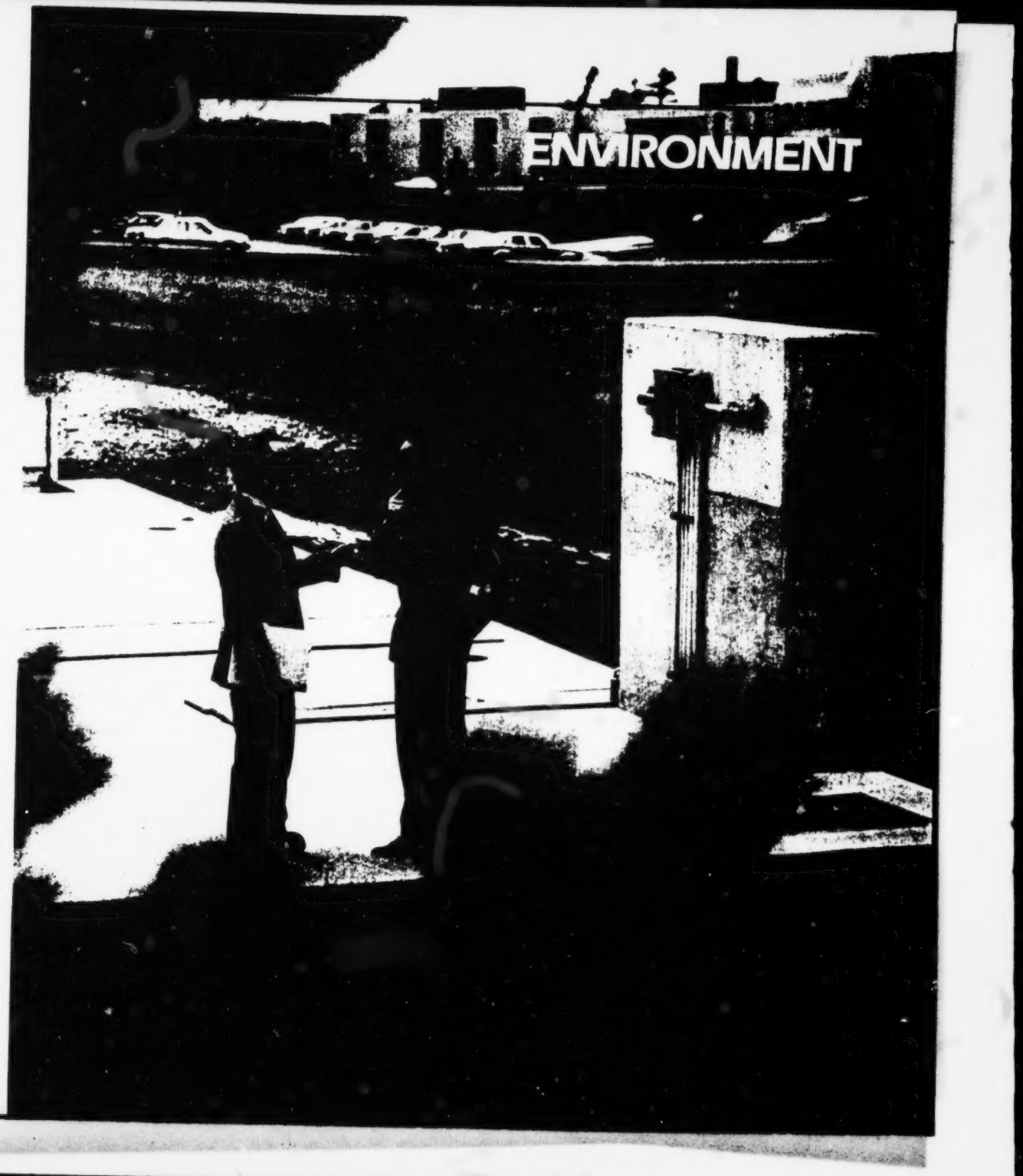
For Energy Mines and Resources Canada, design parameters were developed for the WETOX® process to treat produced water from enhanced oil recovery operations, rendering it suitable for reuse. Batch testing and computer assisted economic assessment indicate the viability of this treatment process and it is hoped that pilot scale testing will be initiated in 1985.

A program to evaluate and optimize a new prototype sewage treatment system using a rotating biological contactor (RBC) was carried out for CMS Rotordisk Inc., completing pilot-scale and full-scale performance trials. Soon after project initiation, the project manager conceived the idea of applying RBC technology to emissions, rather than effluents containing organic contaminants. An internal research program using small pilot-scale equipment indicated that gaseous phenol could be removed from an emission stream at a very high efficiency (better than 99.9% removal) on a continuous basis. Discussions have been held with the principal owner of CMS to consider the establishment of a new company to develop, market and sell RBC units for emission control. A large automotive company, which has been an ORF client for several years, is extremely interested in the application of this technology for phenol control from specific process operations.

A novel process combined thermophilic anaerobic digestion, carbon adsorption and ammonia stripping in a fluidized bed reactor, developed for Environment Canada to treat wastewaters from the thermal processing and dewatering of fuel grade peat.

ANALYTICAL SUPPORT

Several major programs were carried out for industrial and governmental clients in which our extensive analytical capabilities were solely or mainly required. These included analysis of animal tissues for Environment Canada, bitumen analyses for Guelph Chemical Laboratories, pitch and asphalt analyses for EMR, residue analyses for Canadian Wildlife Service and nutrient analyses of ration packs for the Department of National Defence.



Matthew McKim discusses the operation of an institutional scale waste treatment system with Mike Croston of CMS Rotordisk Inc.

Tomorrow's products require tomorrow's materials. Building on its solid base of experience in materials development, ORF is assisting its clients to meet this requirement, as well as in the application of traditional materials in new ways.

BUILDING MATERIALS

A National Research Council (NRC) sponsored program was directed to develop silica aerogel as a light-weight, transparent material for potential applications such as thermal insulation for windows. The material has been successfully prepared in a laboratory scale facility.

A program related to the superwindow development was the experimental study of a low emissivity coating using the sol-gel technology. This dip coating technology also has interesting applications beyond window glass. This program was also sponsored by NRC.

The feasibility of using sol-gel for developing fire protective coatings was also initiated last year on behalf of Defence Research Establishment Atlantic. Coatings and processes for fire protection on ships were investigated.

With rising energy costs, there has been a trend in the construction industry towards the use of industrial by-products such as fly ash and blast furnace slags to partially replace energy-intensive materials such as Portland cement. With this general objective, a study was carried out on behalf of CANMET, Energy Mines and Resources Canada to evaluate the potential application for slags produced by Canadian non-ferrous smelters. It was determined that these materials could provide considerable savings in construction costs, particularly for mine backfill in the remote locations typical of these mines.

Roy Sasaki, (left) Foundry Manager of Supreme Aluminum, discusses an analogue mould operation with Dr. James Sullivan

ADVANCED MATERIALS

On behalf of the Department of National Defence, two programs were initiated in the field of ceramics for diesel engines. One of the programs, supported by the Defence Research Establishment, Ottawa (DREO), aims at the development of plasma-sprayed zirconia based coatings and the performance study of a single cylinder Deutz research engine by incorporating ceramic coated parts. Department of National Defence is interested in evaluating the cold weather performance, and multifuel capabilities of the ceramic engine. The other program sponsored by the Defence Research Establishment, Atlantic (DREA), is to study ceramic wear mechanisms and high temperature lubricants under simulated diesel engine conditions. A laboratory scale wear rig was designed and built for this purpose.

Our long-standing relationship with Blue Mountain Pottery and BM Hi-Tech, Inc. continued. In the area of advanced ceramics for instance, we continued to work with BM Hi-Tech in the development of advanced electronic ceramics for piezo-electric devices. On the consumer side, our scientists worked with a Blue Mountain engineer in the development of a single fired body aimed at reducing processing time for the company's new oven-to-table ware line.

The boron nitride battery separator program continued, in co-operation with Electrofuel Manufacturing Co. Ltd. After development of a laboratory scale low cost method of making boron nitride felt, pilot scale facilities were built.

An initial assessment of Materials Processing in Space (MPS) pertaining to glass and ceramics is being conducted. This contract forms part of the first phase of NRC's program to advance the understanding of MPS and to examine the commercial opportunities for Canada to participate in the U.S. space station program.

In the field of energy related materials under the sponsorship of the NRC we undertook the development of a novel hydrogen storage system based on glass microcapsules.

BIOMATERIALS

Most types of orthodontic brackets are bonded directly to the patients' teeth by means of a special adhesive applied between the etched surface of a tooth and a bonding pad attached directly to the bracket. In a previous investigation undertaken on behalf of Augusta Developments, it was demonstrated that the bonding strength could be enhanced considerably by using a pad incorporating a porous coating. The stainless steel foil from which the pads were made was coated manually, but this process was labour intensive, prone to variations in quality and not easily adaptable to high production rates. In order to overcome the problems inherent to the manual process, Walsh Manufacturing contracted us to develop a prototype facility for coating stainless steel foil in the form of continuous strip. The facility was developed successfully and the excellent quality of the product was demonstrated both in the laboratory and in clinical trials carried out using SPEED™ brackets.

Continuing work on vascular grafts was concentrated in two areas. Fibre cracking problems were considerably reduced by annealing the grafts after manufacturing, and a determination of optimum annealing conditions is now being conducted. A fatigue testing device has also been developed.

METALS TECHNOLOGY

Environmentalists and others have expressed concern with respect to the health hazard represented by lead in the atmosphere. There is a distinct possibility that the use of lead in solders might have to be eliminated or reduced drastically in the future. With this in mind, CRAMCO Solder Alloys, a leading Canadian manufacturer of lead-tin solder products, asked us to investigate the feasibility of developing a substitute solder for joining copper and copper-based alloys. The results of this investigation indicated that by using a suitable flux, solders based in the zinc-tin system exhibited satisfactory mechanical properties in comparison to those of comparable lead-tin solders.

Alloy Casting Industries Ltd., a manufacturer of alloy steel castings, has contracted us to investigate the effects of cast section thickness and heat treatment on the fracture toughness properties of two grades of cast steel designed for low temperature service.

Work continued for Canadian Alloy Castings, exploring

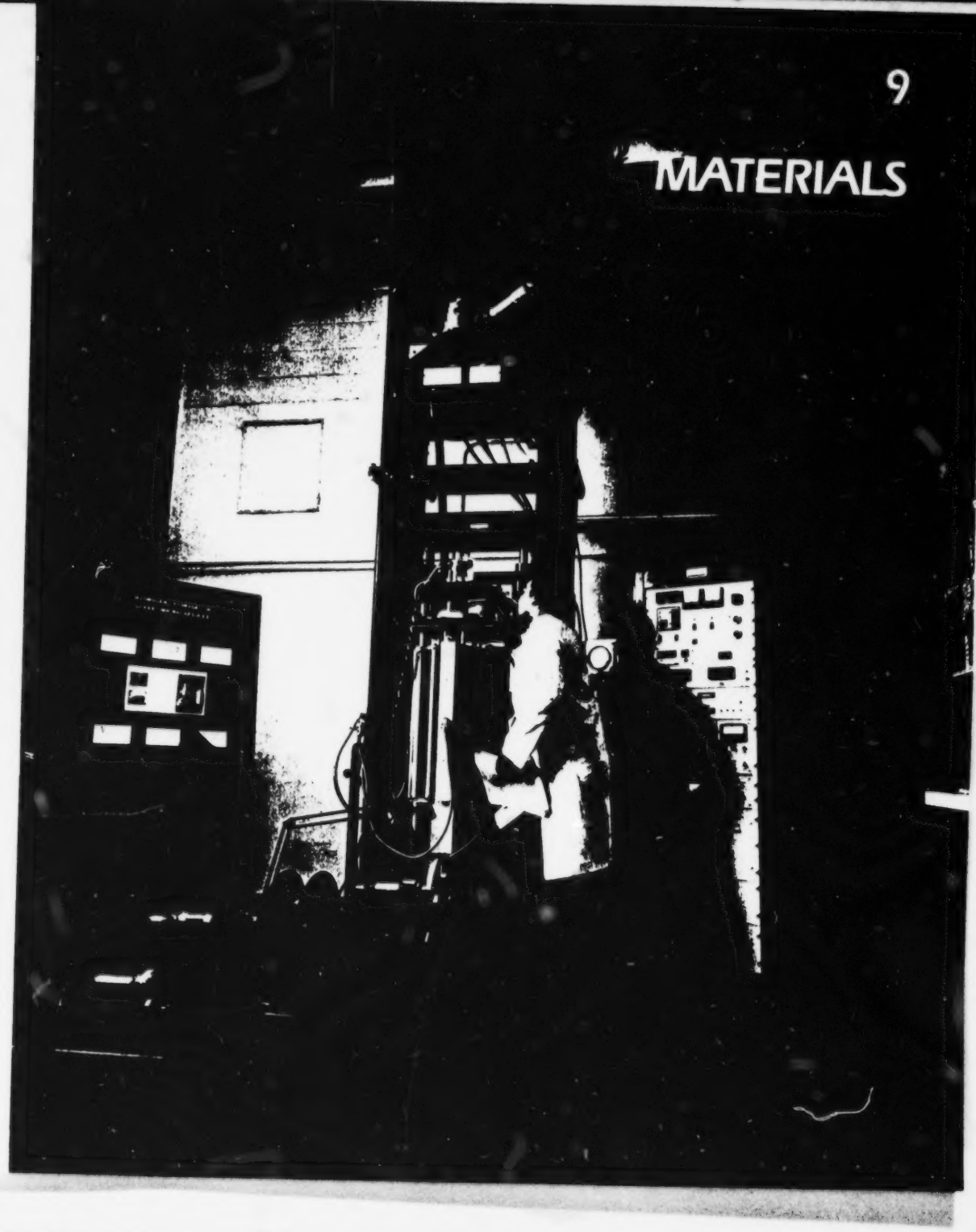
the potential of chemical vapour deposition (CVD) coatings for prolonging the life of graphite permanent moulds. The results of the investigation were sufficiently encouraging to prompt further development of the process on a production scale.

In a program commissioned by Supreme Aluminum, we investigated the feasibility of using analogue models to identify and solve problems associated with gating in permanent mould casting of aluminum. "Gating" is a term employed by the foundry industry to denote the routing of molten metal from a ladle into a mould cavity. In this investigation, the behaviour of molten aluminum in an iron mould system was modelled using aqueous solutions in a clear acrylic mould of the same design. These solutions were coloured and of different viscosities. This behaviour in filling the replica mould was video recorded. Correlation between the visual information and the characteristics of aluminum castings produced by Supreme Aluminum enabled improvement to be made in the gating system.

TEXTILES, FLAMMABILITY AND FOOTWEAR

On behalf of the Department of Consumer and Corporate Affairs, the work related to cigarette ignition of furnishings was continued with a program directed towards upholstered furniture. The work covered five areas and results indicate that it is the material composition of the assembly that really governs whether ignition takes place or not. Work is planned until satisfactory guidelines and test methods are obtained so that the risk of cigarette ignition is drastically reduced.

Work was undertaken to assess the relative fire and explosion hazards of alcohol/gasoline blended fuels to be used in road vehicles. The first phase of the program identified fuel formulations. Current fire fighting techniques were also assessed.



Robert Owles operates fibre drawing apparatus in a program aimed at hydrogen storage.

For the manufacturing industry to compete effectively in export markets, and against imported products in the domestic market, it must be innovative in the goods it produces. One of the prime purposes of our work is to assist industry, particularly small to medium sized companies, by improving designs, developing new and better processes, increasing productivity and solving technical problems.

PULP, PAPER AND WOOD

Based upon work done over a number of years by our Dr. Geza Matolcsy, new technology has been commercialized for the production of 2-ply bathroom tissue by Dominion Cellulose.

Plant trials continued in 1984 and products were produced in late summer for consumer acceptance tests. Public response to the product was extremely favourable and Dominion Cellulose will be going into full production.

For each paper-making machine the annual energy savings are estimated to be more than $1 million versus another major method for producing similar products. Moreover, machine speeds may be 1500 mpm compared to 1000 mpm.

Capital equipment costs are approximately twenty percent of conventional equipment costs for producing a similar product and there is also a savings in material.

Bob Jones uncovers a lead castle containing radioactive coupons

Considerable interest has been expressed by several European companies in licensing the technology and these opportunities will be pursued in 1985.

MICROELECTRONICS

Two commuter trains operated by GO Transit were equipped with instruments to monitor the power required by the coaches for lighting and air conditioning during hot weather. The results of this study were used to evaluate the diesel generator sets presently used by GO Transit, with the goal of reducing costs and/or closer matching of the power generating capacity to the load requirements. A second phase of this program will be conducted in winter 1985-86 to monitor the peak heating requirements.

A complete test facility was established at ORF to analyze photovoltaic water pumping systems. Tests were conducted for the NRC Solar Energy Program in order to identify subsystem combinations producing optimum operating conditions at lowest capital cost. Systems tested were designed to provide pumping systems for irrigation, water supply, or a combination of both, for use in Third World countries.

A manufacturer of X-ray equipment asked us to study the use of thin film in radiographic and electroluminescent devices. The devices were fabricated by depositing very thin layers of various compounds on glass, and evaluating the results. The study determined whether these devices could reduce the X-ray exposure levels.

PRODUCT DESIGN AND EVALUATION

As part of the exploration of new markets for thermal products in the medical/veterinary fields, Meditech Canada requested that we undertake a feasibility study to develop controlled temperature, single-use chemical thermal (heat or cold) packs. The client has identified a need for products of this type in therapeutic applications where controlled heat or cold is temporarily required. Chemically-based thermal products present a number of advantages over traditional methods of applying thermal therapy by offering a controlled temperature without the need for an electrical source, or controls. Financial assistance was obtained under the NRC Industrial Assistance Program. Patents are now pending for ten thermal devices which were designed and developed to the prototype stage.

A study for Transport Canada was initiated this year and will be completed in 1985 to determine criteria for a smoke mask suitable for protection of passengers in commercial aircraft. Data on currently available masks have been collected, testing protocols evaluated and accident statistics reviewed.

PROCESS DESIGN AND DEVELOPMENT

Chlorination of windshield wiper blades imparts surface lubricity and abrasion resistance to the blade. Tridon, a major manufacturer of windshield wipers and blades, wanted to investigate alternatives to their existing chlorination process. A program conducted at ORF dealt with the evaluation of various processes. As a result of this work, a process has been identified that provides significantly improved process economy and higher product quality.

We continued to assist London Nuclear Ltd. by providing a research and process development capability which includes a licensed radioactive materials laboratory and optical, electron optical, chemical and metallurgical analytical facilities. Projects are varied and have included studies of the interrelationships between oxide film composition, morphology and decontamination chemistry, the impact of specific environments on sensitized and non-sensitized metals and research into new processes.

STRESS ANALYSIS AND EQUIPMENT TESTING

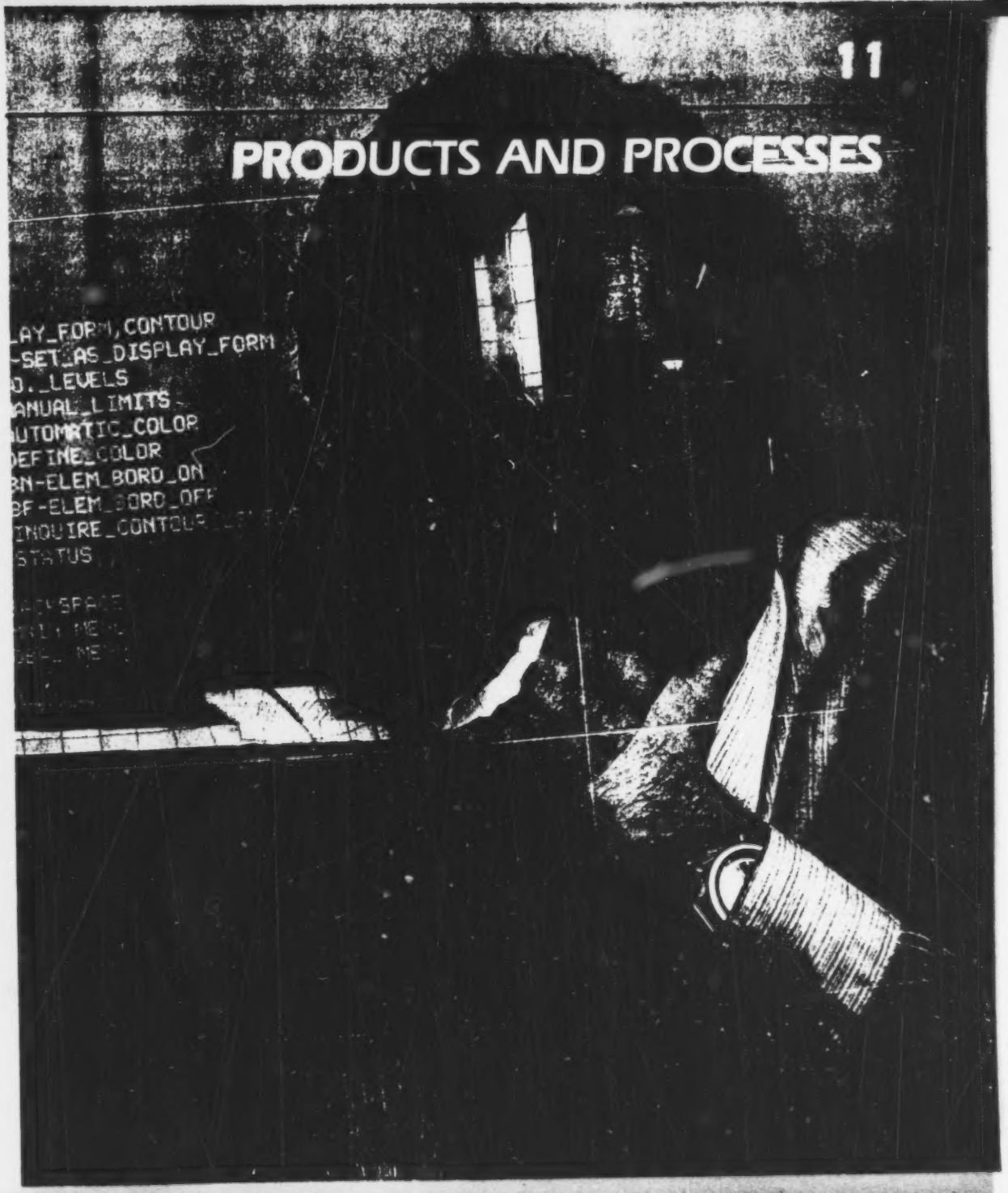
In July, the Computer Aided Engineering (CAE) group was formed at ORF to offer capabilities and services which complement, yet are distinct from, the capabilities of the conventional CAD/CAM facilities found in general industry.

CAE provides system simulation: the dynamic analysis of interaction of components under simulated operating conditions. This process provides the design specifications of components for optimum design.

We invested in the VAX 11/750 and the GenRad 2515 hardware, together with the CAE "IDEAS" software of Structural Dynamics Research Corporation. The services are integrated, enabling many engineering functions to share a common database.

Flyer Industries, Ltd. of Winnipeg, Manitoba, in the interest of building better buses, has employed the services of the Computer Aided Engineering group to gain insight to the structural integrity of their buses via the application of finite element modelling coupled with the performance of road operating tests and in laboratory experimental modal analysis.

PRODUCTS AND PROCESSES



In 1985, CAE business will be expanded to include defence research. Future business will be gained from in-plant trouble-shooting on capital equipment, and vehicle design trouble-shooting.

PACKAGING TECHNOLOGY

At the request of the Science Centre, Supply and Services Canada, our packaging group investigated methods of converting the conventional gable-top paperboard carton into a high barrier package. The investigation used materials and methods to seal the paperboard carton edge against oxygen permeation. The various edge seals included coating, wrapping, and laser "skiving" and folding of foil edge. Systems using metallic aluminum foils provided the best barrier. Laser skiving was successful, but a reduced production speed and major capital outlay are severe drawbacks to its use.

A development project for Crown Cork and Seal was undertaken in 1984. This involved reformulation and testing of new vinyl plastisol materials for use in bottle caps. Various combinations of additives were evaluated and a number of formulations submitted to the client for evaluation.

PRODUCTIVITY

We conducted an operations analysis for a pottery company producing an extensive line of ceramic ware. The study analyzed capabilities and improvement opportunities, and direct assistance was rendered to the company during the implementation stage.

A leading hardware manufacturer, faced with significant off-shore competition and deteriorating profits, contracted us to conduct a productivity improvement study. An internal task force was set up to focus on value analysis, in a new consultative methodology known as Enhanced Productivity through Innovation Circles (EPIC). This approach shifts the consultant's role to that of a catalyst and facilitator for idea generation. A significant degree of understanding and commitment was generated during the implementation of recommendations.

FOOD

A 5-year program for the International Technical Caramel Association (ITCA) to define composition of caramel colour, evaluate its homogeneity, and prepare specifications for use throughout the world was completed at the end of the year.

Tom Judek is a member of the Computer Aided Engineering group formed in July.

We have worked closely with the forestry and mineral industries to develop more efficient use of these resources with a minimum impact on the environment. Particular emphasis has been placed on our facilities and capabilities for pilot scale work.

MINERAL PROCESSING

Asbestos technology continued to be a major study area at ORF in 1984. The Alaska Asbestos project, to recover and evaluate asbestos from drill core samples from a major asbestos resource in Alaska, came to a conclusion in December. This program, which had spanned six years, was sponsored by a consortium consisting of G.C.O. Minerals Company, and Tanana Inc., a subsidiary of Doyon Limited, an Alaska Native Regional Corporation.

During the course of the study, this project concerned the evaluation of process technology and the determination of optimum fibre recoveries from small and large drill cores, requiring the installation of a mini-pilot plant processing line. Activities in 1984 principally concerned the evaluation of the fibre obtained from the drill cores with a view to determining the quality and value of the ore body and determining typical grade specifications for products which might be produced. Alternative process technologies and process improvements demanded by the characteristics of the ore body were also evaluated.

Gary Musson works the ORF Flash Hydropyrolysis rig.

Under contract to the Canada Centre for Mineral and Energy Technology (CANMET) of the Department of Energy, Mines and Resources, ORF has been active in the development and evaluation of CANMET's new wet processing technology for the extraction of fibre from tailings and ore bodies. This program was initiated to determine the energy benefits of changing from conventional dry-milling and air aspiration techniques to wet-processing.

The Cassiar Asbestos Division of Brinco Mining also continued to utilize our facilities. We acted as its research arm, providing technical services to both the company and its clients in a variety of areas. In 1984 main areas of activity included: the development of new testing equipment, procedures, and correlation with current specifications; market assistance; fibre development programs; and problem solving.

FUEL RESOURCES

Development of peat dewatering and processing technology continues to be of interest in Ontario due to its potential future use as a fuel using significant Ontario sources of raw material. For NRC, a project was initiated to evaluate the dewaterability of peat by partial wet oxidation and to assess the environmental implications of process effluent.

Chemical and biological characterization of wastewaters from peat dewatering was completed for Environment Canada. Of five different peat dewatering processes, one using microbial action and a rotary press produced waters very low in all pollutant parameters.

A project carried out for Monenco involved the characterization of several peat slurries at various solids concentrations with respect to viscosity.

As sub-contractors to SENES Consultants Ltd. on a study of biomass-to-energy technology, likely candidate processes were identified for commercialization. Emphasis was on process mass balance development and characterization of major processes and waste streams. The study was primarily to assess environmental and occupational health implications.

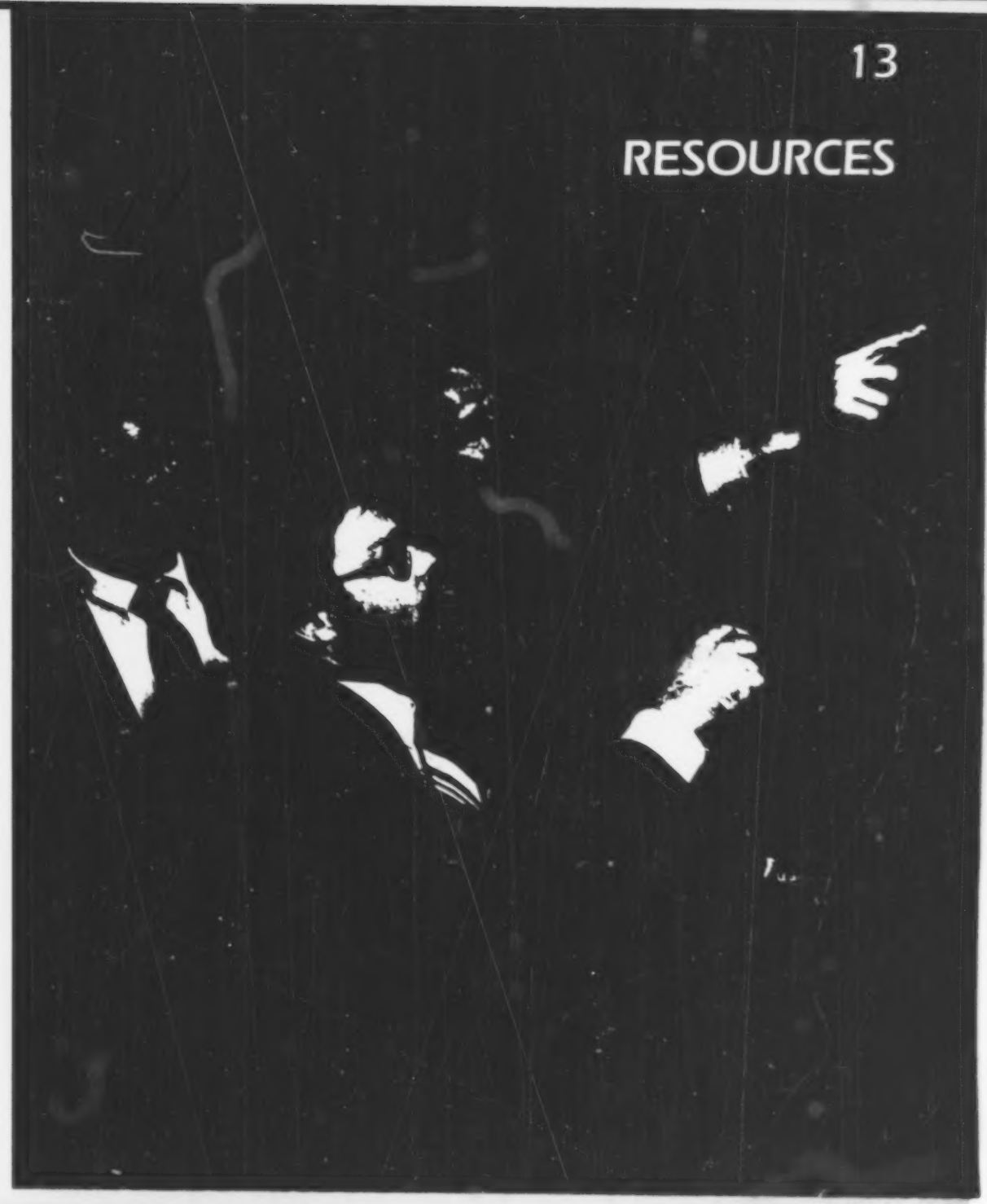
The Energy Systems Centre is establishing a dedicated biomass facility at ORF, with a targeted operational date of September, 1985. Biomass combustion is a new field using renewable resources such as straw and wood refuse as fuel.

Studies have continued this year for National Research Council (NRC) in developing fermentation technology for producing ethanol from sugars using a specific yeast.

We operate a laboratory scale reactor for the Canada Centre for Mineral and Energy Technology (CANMET). Our objective is to establish the optimum parameters for the production of liquid fuels from various Canadian coals. The typical carbon conversions are: 20% into liquid, 30% into gaseous and 50% into solid fuels. With improved operational proficiency higher pressures will be used for increased liquid yields.

13

RESOURCES



Lucius V. Clark of GCO Minerals and Harold J. Noyes of Doyon Ltd. discuss the Alaska Asbestos project with ORF's Craig Booth.

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AUDITORS' REPORT

To the Board of Governors of Ontario Research Foundation

We have examined the consolidated balance sheet of Ontario Research Foundation as at December 31, 1984 and the consolidated statements of income and unappropriated surplus, fixed asset contributions and changes in financial position for the year then ended. Our examination was made in accordance with generally accepted auditing standards and accordingly included such tests and other procedures as we considered necessary in the circumstances.

In our opinion these consolidated financial statements present fairly the financial position of Ontario Research Foundation as at December 31, 1984 and the results of its operations and the changes in its financial position for the year then ended in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Toronto, Canada
January 31, 1985

Allen Miles Fox & Johnston

ALLEN, MILES, FOX & JOHNSTON
Chartered Accountants

Approved on behalf of
the Board of Governors

John D. Houlding

W. Steven

FINANCIAL STATEMENTS

CONSOLIDATED BALANCE SHEET

as at December 31, 1984

	1984	1983
ASSETS		
Current Assets		
Short-term deposits	$ 1,000,873	$ 1,029,562
Accounts receivable	4,617,660	3,611,520
Accrued interest receivable	8,258	11,081
Inventory of stores	97,391	104,808
Prepaid expenses	127,454	177,960
	5,851,636	4,934,931
Investments (note 2)	1,362,528	1,214,694
Fixed Assets (note 3)	14,376,535	14,178,785
	$21,590,699	$20,328,410
LIABILITIES		
Current Liabilities		
Bank indebtedness	$ 132,957	$ 114,017
Accounts payable and accrued liabilities	2,107,575	1,138,448
Amounts received in advance for research and other projects	309,703	225,154
	2,550,235	1,477,619
CAPITAL		
Capital Contributions	3,363,100	3,363,100
Fixed Asset Contributions	6,404,784	6,228,903
Appropriated Surplus (note 4)	9,250,000	9,250,000
Unappropriated Surplus	22,580	8,788
	19,040,464	18,850,791
	$21,590,699	$20,328,410

CONSOLIDATED STATEMENT OF INCOME AND UNAPPROPRIATED SURPLUS

for the year ended December 31, 1984

	1984	1983
REVENUE		
Professional services	$16,326,786	$14,118,777
Performance grant from the Province of Ontario (note 5)	3,750,000	3,987,000
Investment income	346,081	216,206
Royalties	469,353	305,800
Other	57,313	109,891
	20,949,533	18,737,674
EXPENSE		
Salaries and benefits	12,364,873	11,237,506
Other costs of research	7,723,658	6,541,675
General	1,597,329	1,164,530
	21,685,860	18,943,711
Loss from operations	736,327	206,037
Transfer from fixed asset contributions	750,119	711,393
Income for the year	13,792	505,356
Unappropriated surplus, beginning of year	8,788	3,432
	22,580	508,788
Appropriation for replacement and expansion of physical plant	—	500,000
Unappropriated surplus, end of year	$ 22,580	$ 8,788

CONSOLIDATED STATEMENT OF FIXED ASSET CONTRIBUTIONS

for the year ended December 31, 1984

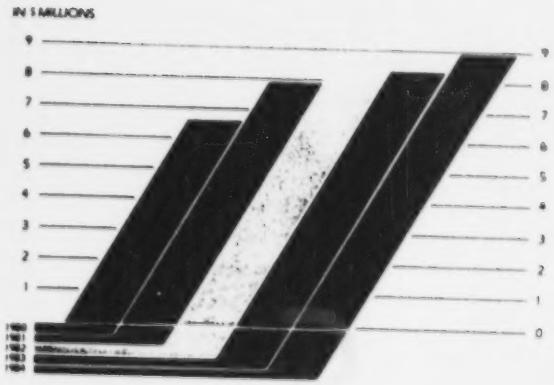
	1984	1983
Fixed asset contributions, beginning of year	$ 6,228,903	$ 6,328,296
Fixed asset contributions received from the Province of Ontario (note 5)	926,000	612,000
	7,154,903	6,940,296
Transfer to income	750,119	711,393
Fixed asset contributions, end of year	$ 6,404,784	$ 6,228,903

CONSOLIDATED STATEMENT OF CHANGES IN FINANCIAL POSITION

for the year ended December 31, 1984

	1984	1983
Source of working capital		
Operations		
Income for the year	$ 13,792	$ 505,356
Items which do not affect working capital		
Depreciation	1,802,198	1,723,455
Transfer from fixed asset contributions	(750,119)	(711,393)
	1,065,871	1,517,418
Net decrease in investments	—	144,971
Fixed asset contributions (note 5)	926,000	612,000
	1,991,871	2,274,389
Use of working capital		
Net increase in investments	147,834	—
Cost of construction	157,498	276,819
Acquisition of apparatus and instruments (net)	1,691,484	954,762
Acquisition of other fixed assets (net)	150,966	234,693
Reduction of long-term portion of bank loan	—	360,000
	2,147,782	1,826,274
Increase (decrease) in working capital	(155,911)	448,115
Working capital, beginning of year	3,457,312	3,009,197
Working capital, end of year	$3,301,401	$3,457,312

Industrial Income Growth



NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

December 31, 1984

1. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

A. Principles of Consolidation
These consolidated financial statements include the accounts of Ontario Research Foundation and its wholly-owned subsidiary, Ordco Technology Limited.

B. Inventory of Stores
Inventory of stores is valued at the lower of cost and replacement cost.

C. Fixed Assets and Depreciation
Fixed assets are stated at cost. Depreciation is provided on a straight-line basis at the following annual rates:

Buildings	3-1/3% and 5%
Equipment	6-2/3%, 10%, 15% and 20%
Automotive equipment	33-1/3%

D. Capital Contributions
Capital contributions comprise the original capital sums donated by the Province of Ontario and industry, the income from which is being used to assist in meeting annual expenses in accordance with the terms of the contributions.

E. Method of Computing Revenue

Professional Services Revenue
Professional services revenue is recognized on the basis of the percentage of completion of the work at estimated fees earned or at per diem billing rates depending upon the contractual arrangements.

Fixed Asset Contributions
Fixed asset contributions received from the Province of Ontario and industry are included in capital and are transferred to income over the useful lives of the related assets.

Gains on Sale of Investments
Net gains realized on the sale of investments are reflected as revenue in the statement of income.

The policies with respect to accounting for fixed asset contributions and for the net gains on the sale of investments were retroactively adopted as of January 1, 1983 resulting in an unanticipated surplus in 1983 amounting to $505,356, of which $500,000 was appropriated for the replacement and expansion of the physical plant. The foreknowledge of such accounting treatment in 1984 permitted the reinvestment of any anticipated surplus in operations during the current year.

2. INVESTMENTS

	1984	1983
Short-term deposits, at cost	$ 416,279	$ —
Bonds, at amortized cost		
Government, direct and guaranteed	198,695	396,409
Public utility	—	99,963
Industrial and other	23,000	23,000
Common stocks, at cost	724,554	695,322
	$1,362,528	$1,214,694
Quoted market value	$1,992,767	$1,911,456

3. FIXED ASSETS

	1984			1983
	Cost	Accumulated Depreciation	Net	Net
Land	$ 597,438	$ —	$ 597,438	$ 597,438
Buildings	12,460,620	4,909,995	7,550,625	7,884,158
Equipment	16,428,738	10,232,217	6,196,521	5,679,152
Automotive equipment	112,840	80,889	31,951	18,037
	$29,599,636	$15,223,101	$14,376,535	$14,178,785

4. APPROPRIATED SURPLUS

Surplus has been appropriated for the replacement and expansion of the physical plant. The balance of surplus appropriated for anticipated improvements to the Improved Retirement Plan on March 1, 1985, which amounted to $375,000 at December 31, 1983, has been transferred to surplus appropriated for the replacement and expansion of the physical plant.

5. GRANTS FROM THE PROVINCE OF ONTARIO

In 1984, Ontario Research Foundation received from the Province of Ontario grants totalling $4,676,000 of which $3,750,000 has been allocated to income and $926,000 to fixed asset contributions.

6. CONTINGENT LIABILITIES

A. A claim in the amount of $50,000,000 has been made against Ontario Research Foundation and eight other defendants alleging unlawful conspiracy among the defendants.

B. A claim for damages alleging negligence in approving the safe use of urea formaldehyde has been made against Ontario Research Foundation and thirteen other defendants.

C. Two claims regarding employment terminations have been made against Ontario Research Foundation.

Ontario Research Foundation is disputing these claims and has instructed its solicitors to defend its position. The extent of the losses, if any, and the legal fees associated with these claims cannot be estimated at this time.

1191 **Robey, H.L.** **Laughlin, R.G.W.** **Gooderham, P.S.**
"Demonstration of a Batch Hydrolysis System for Destruction of Cyanides in Electroplating Effluents". Proceedings of the First International Conference on Industrial and Hazardous Wastes, Toronto, Canada, 212-227, October 1982.

1192 **Shimizu, H.** **Urednicek, M.** **Lo, J.** **Gibbon, W.M.**
"Application of Liebowitz-Eftis Nonlinear Method to Fracture Control of Welded Structures". 15th Annual Offshore Technology Conference, Houston, Texas, 127-132, May 1983.

1193 **Mogan, J.P.** **Westaway, K.C.** **Horton, A.J.** **Dainty, E.D.**
"Polynuclear Aromatic Hydrocarbons and Mutagens in the Air of Underground Dieselized Mines". Proceedings of Specialized Meeting of International Section of ISSA for the Prevention of Occupational Risks in the Mining Industry, Xth World Congress, Ottawa, Canada, 152-166, May 1983.

1194 **Gallo, T.** **McKim, M.**
"Energy Recovery from Wet-Mined Peat Through Wet Air Oxidation". Proceedings of International Symposium on Peat Utilization, Bemidji, Minnesota, 173-188, October 1983.

1195 **Das, B.S.** **Poirier, M-A.**
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1196 **Laughlin, B.**
"Don't waste it – exchange it". Chemtech, 93-96, February 1984.

1197 **Mulholland, D.L.**
"Studies of a Novel Ethanol Fermentor Purifier". Bioenergy R & D Seminar, Ottawa, Ontario, March 1984.

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"Assessment of Wet Oxidation of Agricultural Residues to Form Fermentation Substrates". Bioenergy R & D Seminar, Ottawa, Ontario, March 1984.

1199 **Chatfield, E.J.**
"Short Mineral Fibres in Airborne Dust". Proceedings from a Symposium – Short and Thin Mineral Fibres. National Board of Occupational Safety and Health, Solna, Sweden, 9-76, 1983. Also published in Arbete och Hälsa, Vetenskaplig Skriftserie 1983:19, Sweden 1983.

1200 **Chatfield, E.J.**
"Analysis of Asbestos in Environmental Samples". Environmental Contamination, International Conference – London, July 1984. Co-Sponsor United Nations Environment Programme (IRPTC).

1201 **Chatfield, E.J.**
"Fiber Definition in Occupational and Environmental Asbestos Measurements". American Society for Testing and Materials, Special Technical Publication 834, 118-138, 1984.

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"Updated Analytical Method for Analysis of Asbestos in Water". Proceedings of Seventh Annual Analytical Symposium, U.S. Environmental Protection Agency Effluent Guidelines Division, Norfolk, Virginia, 291-331, March 1984.

1203 **Leidner, J.**
"Approaches to Secondary Recycling of Plastics". National Research Council Canada, Industrial Materials Research Institute, "Polyblends '84" Mini-Symposium, Boucherville, Quebec, 12.1-12.11, April 1984.

1204 **Dwivedi, R.K.** **Kay, D.A.R.**
"Thermodynamics of the Oxidation of Rare Earth Oxysulfides at High Temperatures". Metallurgical Transactions B, Volume 15B, 523-528, September 1984.

1205 **Dwivedi, R.K.** **Kay, D.A.R.**
"Thermodynamics of high temperature oxidation of La_2O_2S and Nd_2O_2S at high sulphur partial pressure". Journal of Materials Science Letters, 3, 983-986, 1984.

1206 **Dwivedi, R.** **Johar, S.** **Gibbon, M.** **Nimkar, S.** **Hollingshead, R.**
"Preparation of rapidly solidified copper-based alloys by meltspinning". Journal of Materials Science Letters, 3, 975-978, 1984.

1207 **Balbaa, I.S.** **Prasad, S.E.** **Yan, K.L.** **Johar, S.**
"Piezoelectric Composite Materials". Journal of the Canadian Ceramic Society, Volume 53, 5-7, 1984.

1208 **Nguyen, D.** **van Roode, M.** **Sze, W.** **Johar, S.**
"Zirconia Coatings prepared by Spray Pyrolysis". Journal of the Canadian Ceramic Society, Volume 53, 34-38, 1984.

1209 **Kapadia, M.** **van Roode, M.** **Roy, R.**
"The Kinetics and Mechanism of Matte Glaze Formation". Journal of the Canadian Ceramic Society, Volume 53, 39-43, 1984.

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"Annealing Kinetics of Rapidly Solidified Brass Powders". Proceedings of the 1984 International Powder Metallurgy Conference, Toronto, June 1984.

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"Time Dependent Parameters in Dynamic Fracture". Proceedings of the 11th Canadian Fracture Conference, Ottawa, June 1984.

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1212 **Booth, C.A.** **Joyce, I.H.** **Kuntze, R.A.**
"The Alaska asbestos project: Asbestos fibre separation and evaluation". 6th 'Industrial Minerals' International Congress, Toronto, May 1984.

1213 **Ellison, W.** **Luckevich, L.M.**
"FGD waste: Long-term liability or short-term asset?" Power Magazine, 79-83, June 1984.

1214 **Lakshmanan, V.I.** **Luckevich, L.M.** **Ritcey, G.M.** **Skeaff, J.M.**
"Evaluation of Tailings Stabilization Methods as Applied to Uranium Tailings". Hydrometallurgy, 12, 31-48, 1984.

1215 **Lakshmanan, V.I.** **Ashbrook, A.W.**
"Radium Balance Studies at the Beaverlodge Mill". Journal of Radioanalytical and Nuclear Chemistry, Articles 84/1, 53-66, 1984.

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"Treatment of Refractory Gold Ores". Proceedings of the 14th Annual Hydrometallurgical Meeting, Timmins, Ontario, October 1984.

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"Update of Water/Fuel Emulsification Effects on Diesel Emissions Reduction". Energy, Mines and Resources Canada, CANMET Division Report ERP/MRL 84-4(OP,J). January 1984.

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"An Evaluation of an Emissions Control Strategy for Underground Diesel Mining Equipment". SAE Congress and Exposition, Detroit, Michigan, February 1984.

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"Set-up and Operation of a Facility for Performance Testing of Air-to-Air Heat Exchangers". Proceedings of the 10th Annual National Conference of the Solar Energy Society of Canada, Calgary, Alberta, 260-264, August 1984.

SOME OF OUR CLIENTS

Agriculture Canada
Alloy Casting Industries Ltd.
Augusta Developments
Blue Mountain Pottery
Brinco Mining
Canadian Alloy Castings
Canadian Electrical Association
Canadian Solifuels Ltd.
CANMET
Consumer and Corporate Affairs Canada
CRAMCO Solder Alloys
Crown Cork and Seal
Department of National Defence
Dominion Cellulose
Doyon Limited
Electrofuel Manufacturing Co. Ltd.
Energy, Mines and Resources Canada
Environment Canada
Flyer Industries Ltd.
GCO Minerals Company
GO Transit
Hatch Associates Ltd.
IEA Consulting Group
International Technical Caramel Association
Keeprite Inc.
Lambton Industrial Society
London Nuclear Ltd.
Meditech Canada
MEP Limited
Michigan Technological University
National Research Council
Ontario Waste Management Corporation
SENES Consultants Ltd.
Supreme Aluminum
Tanana Inc.
Tridon Ltd.
U.S. Bureau of Mines
VIA Rail Canada Inc.

Patrick O'Charchin of Meditech Canada discusses his company's new heat pack with Dr. Ray Hemmings.

ASSISTANCE TO OUTSIDE ORGANIZATIONS

Air Pollution Control Association
American Association of Textile Chemists and Colorists
American Powder Metallurgy Institute
American Society of Brewing Chemists
American Society of Heating, Refrigeration and Airconditioning Engineers
American Society for Testing and Materials
Associate Committee on the National Fire Code
Association of Official Analytical Chemists
Association of Professional Engineers of Ontario
Association of Provincial Research Organizations

Board of Trade of Metropolitan Toronto

Canada/Commission of European Communities
Canada Association of Textile Colourists and Chemists
Canadian Association of Fire Chiefs
Canadian Carpet Institute
Canadian Ceramic Society
Canadian General Standards Board
Canadian Geotechnical Society
Canadian Institute of Mining and Metallurgy
Canadian Manufacturers' Association
Canadian Nuclear Society
Canadian Pulp and Paper Research Committee
Canadian Research Management Association
Canadian Society for Industrial Engineering
Canadian Society for Professional Engineers
Canadian Standards Association
Canadian Uranium Products
Chemical Institute of Canada
Committee on Extension of Coverage for the Fire Fighting Section Under the Occupational Health & Safety Act
Construction Safety Association of Ontario
Council on Protective Equipment

Electrochemical Society (Ontario/Quebec Section)
Engineering Institute of Canada
Environment Canada
Eurogypsum-Working Community of the European Gypsum Industry

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Health and Welfare Canada

Institute of Textile Science
Institution of Production Engineers
International Confederation for Thermal Analysis
International Mineralogical Association
International Organization for Standardization
International Society for Industrial and Hazardous Waste
Inter-Society Color Council

Journal of Thermal Analysis

National Fire Protection Association
National Research Council of Canada
National Sanitation Foundation
Natural Sciences and Engineering Research Council of Canada (NSERC)

Occupational Hygiene Association of Ontario
Ontario Association of Certified Engineering Technicians and Technologists
Organization for Economic Cooperation and Development

Pollution Probe

Réunion Internationale des Laboratoires d'Essais et de Recherches sur les Matériaux et les Constructions (RILEM)
Royal Commission on Asbestos

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Sheridan Park Association
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Source Evaluation Society
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Thermal Analysis Abstracts

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